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OITHONA WELLERSHAUSI, NEW SPECIES, AND *O. SPINULOSA* LINDBERG, 1950 (COPEPODA: CYCLOPOIDA: OITHONIDAE) FROM THE MOUTH OF THE PEARL RIVER, CHINA

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Abstract.—Two tropical, inshore, rostrate, species of the genus *Oithona, O. wellershausi,* n. sp. and *O. spinulosa* Lindberg, 1950, are described from the mouth of the Pearl River, China. The relation of these two Indo-Pacific species to *O. brevicornis* Giesbrecht, 1891, is discussed.

Introduction

From 1954 to 1959 the Fisheries Research Unit of the University of Hong Kong conducted an investigation of the outflow of the Pearl River, from its mouth to the edge of the continental shelf. The study was directed by Dr. F. D. Onmanney. Plankton samples collected during the survey were later transferred to the Fisheries Research Station in Aberdeen, Hong Kong. In 1963 about 1500 of these samples were donated to the Smithsonian Oceanographic Sorting Center by Dr. A. J. Bruce, Research Officer at the Station.

During an examination of the copepods from about 50 surface samples, a number of oithonids of the genus *Oithona* were found in 15. The samples were collected between 22°13′ to 22°15′N and 113°52′ to 115°05′E. Most specimens could be assigned tentatively to common neritic species, *Oithona simplex, O. nana,* and *O. plumifera.* A separate study of these animals is to be published. A few specimens of two rostrate, inshore species, *Oithona wellershausi,* n. sp. and *O. spinulosa* Lindberg, 1950, were also found. Descriptions of these specimens are followed by a discussion of their relations to *O. brevicornis* Giesbrecht, 1891.

Oithona wellershausi, new species
Figs. 1D–F, 2E–H, 3E–H, 4D–F, 5G–L, 6E–H, 7E–H

? *Oithona brevicornis* forma *aruensis* (females only) Früchtl, 1924:88, fig. 44.

? *Oithona brevicornis* smaller form Wellershaus, 1969:282, figs. 107–108.

? *Oithona brevicornis* forma *minor* Nishida *et al.,* 1977:131, figs. 4a, b, 5a–c; Ushima, 1979:59, figs. 1–5.

Female.—Length range 0.45–0.50 mm (30 specimens); Pr/Ur ~ 1.3. Anterior Pr smoothly rounded dorsally, produced as a rostrum laterally (Figs.

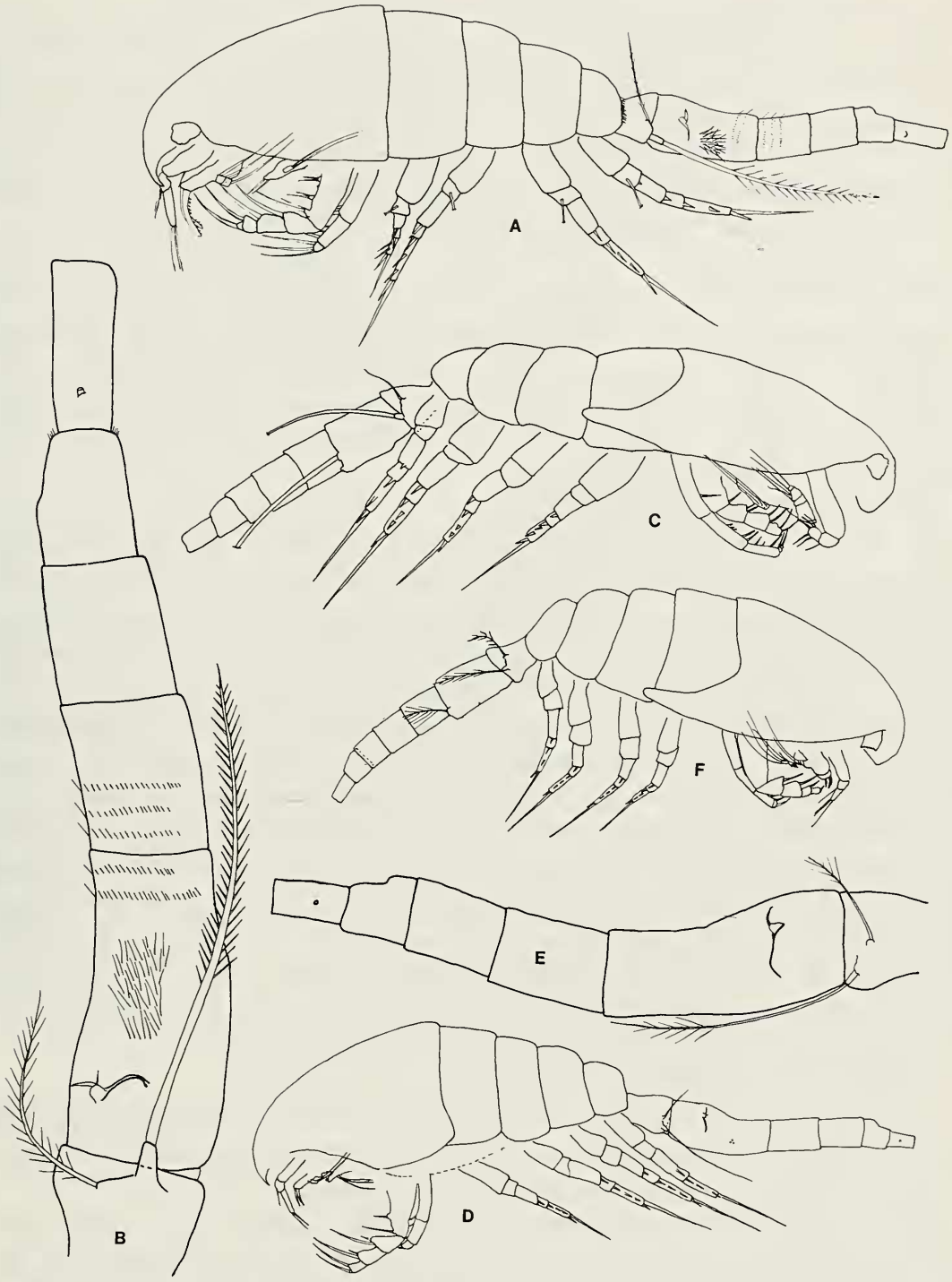

Fig. 1. *Oithona spinulosa*. Female: A, Habitus lateral; B, Ur lateral; Male: C, Habitus lateral. *Oithona wellershausi*. Female: D, Habitus lateral; E, Ur lateral; Male: F, Habitus lateral.

3F, G). Percentages of Ur segments & CR—14:36:16:14:9:11; CR (length/width) ~ 2.2/1. Bsp2Mn (Fig. 3E) 2 thick, slightly curved spines with spinules denser on lateral spine than medial; Re incompletely articulated with 5 setae, apical 2 broken on these specimens; Ri 4 setae, proximal with setules. Bsp1Mx1 (Fig. 4D) with usual armature of strong spines but ventralmost unusually long, more than 2× length of any other; Bsp2 3 thin spines, 2 with spinules; Re 1 segment, 3 setae; Ri 3 setae. ReP1–4 with 1-1-3, 1-1-3, 1-1-3, 1-1-2 Se (Figs. 6E, F, 7E, F). Bsp1–2P4 with hairs in rows or patches; SeRe1 minute; remaining Se increasing in length distally; Ri1 with hairs on posterior surface; Si1Ri2 unmodified Si2 slightly curved with flange on distal ¼; Si1Ri3 longer and thicker, slightly curved with flange on distal ½. P5 as in Fig. 1E. Armature near genital opening a single curved spine. CR (Fig. 5I) dorsal seta with setules; Se, inserted ⅓ distance from anterior margin, 0.9× length of CR.

Male.—Length range 0.43–0.46 mm (18 specimens); Pr/Ur ~ 1.6/1. Anterior Pr rounded dorsally, rostrum absent. Cph flap (Fig. 1C) extending beyond posterior articulation of Pg1. Pore signature (Fig. 4F) of 'hebes' type; anterodorsal cluster 2 slightly sinuous, parallel lines of organs oriented almost dorsoventrally; anterior line 11–13 organs, posterior 10–12; horizontal row essentially a single line of organs terminating posteriorly between 11th and 12th column; 12 columns, 1st immediately ventral to anterodorsal cluster; horizontal series, generally as a double row of organs along ventral edge of Cph and flap, except between 4th and 5th column as a single row. A2 segment 3 (Fig. 5J) longer than in female. Bsp2Mn (Fig. 3H) 2 thin spines with long spinules; Re 5 setae, apical brush-like; Ri 4 setae, proximal with setules. Bsp1Mx1 (Fig. 4E) with elongate ventral spine; Bsp2 3 thin spines; Re 1 segment, 3 setae; Ri 3 setae. ReP1–4 with 1-1-3, 1-1-3, 1-1-3, 1-1-2 Se (Figs. 6G, H, 7G, H). P4 lacking hairs and modified setae. P5 simple (Fig. 1F). Genital flap with 1 seta. CR (length/width) 1.6/1; all setae (Fig. 5L) relatively smaller than in female; dorsal apparently naked.

Remarks.—see Discussion section.

Etymology.—This species is named in honor of Dr. Stefen Wellershaus for his exemplary descriptions of the Cochin specimens and his valuable compilation of information on oithonid morphology.

Type-material.—Female holotype (USNM 184587) from Pearl River Plankton Collection; Cr. 0; St. 23; 22°13.2′N, 114°09.8′E, 3 Aug 1954, surface. 46 female and 13 male paratypes (USNM 184588) various stations from 22°13′ to 22°15′N and 113°52′ to 115°05′E, 1955–1959, surface.

Oithona spinulosa Lindberg, 1950

Figs. 1A–C, 2A–D, 3A–D, 4A–C, 5A–F, 6A–D, 7A–D

Oithona spinulosa Lindberg, 1950:259, figs. 1–2.

Oithona brevicornis typical form Wellershaus, 1969:279, figs. 103–106, 109–119.

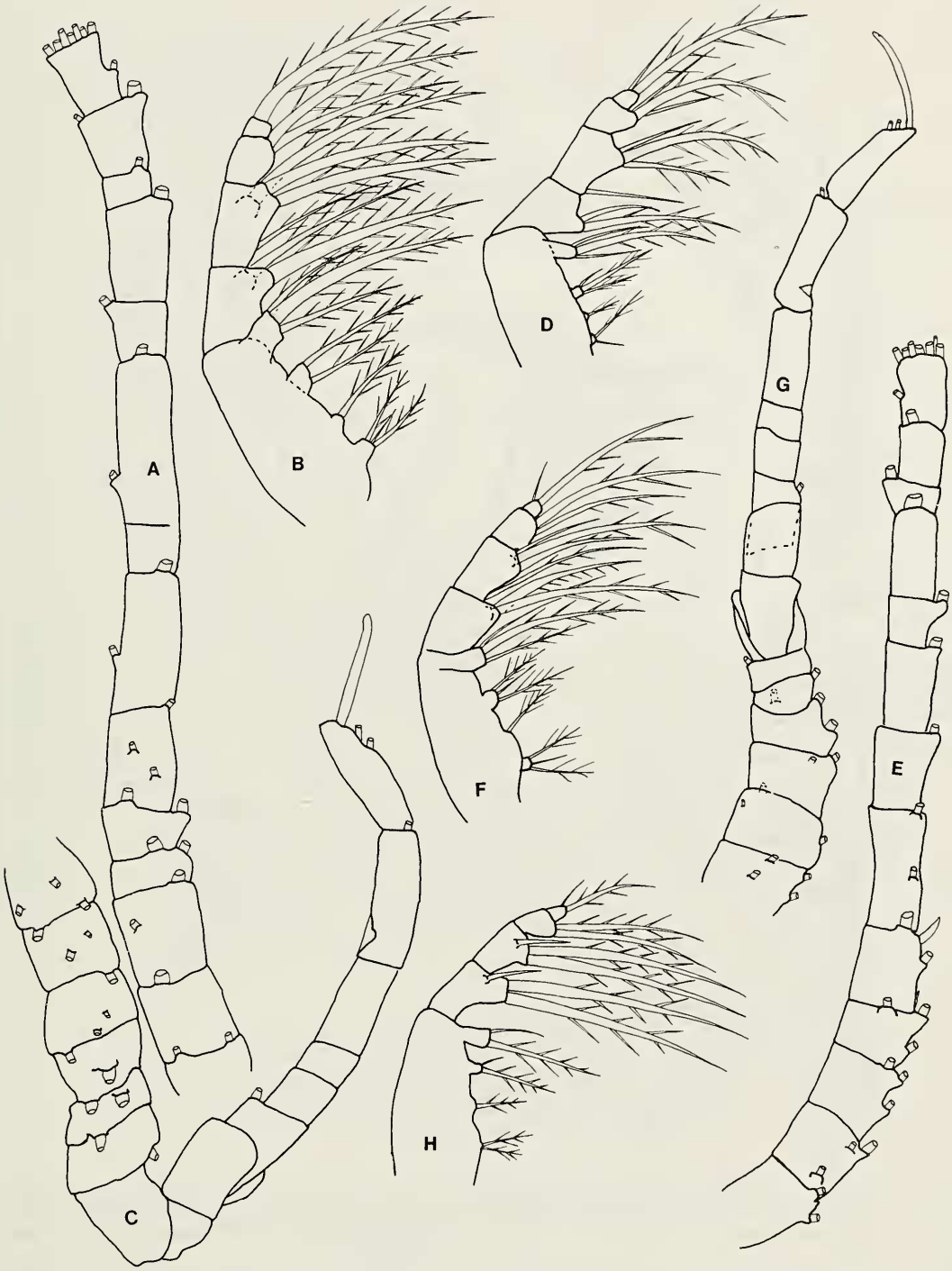

Fig. 2. *Oithona spinulosa*. Female: A, A1; B, Mx2; Male: C, A1; D, Mx2. *Oithona wellershausi*. Female: E, A1; F, Mx2; Male: G, A1; H, Mx2.

? *Oithona brevicornis* forma *typica* Nishida *et al.*, 1977:53, figs. 1c–h, 2b.

Female.—Length range 0.57–0.64 mm (30 specimens); Pr/Ur ~ 1.3. Anterior Pr (Fig. 3C) dorsally tapering toward a distinctly rounded projection; laterally produced as a rostrum. Pg4 with tiny hairs on posterior edge. Per-

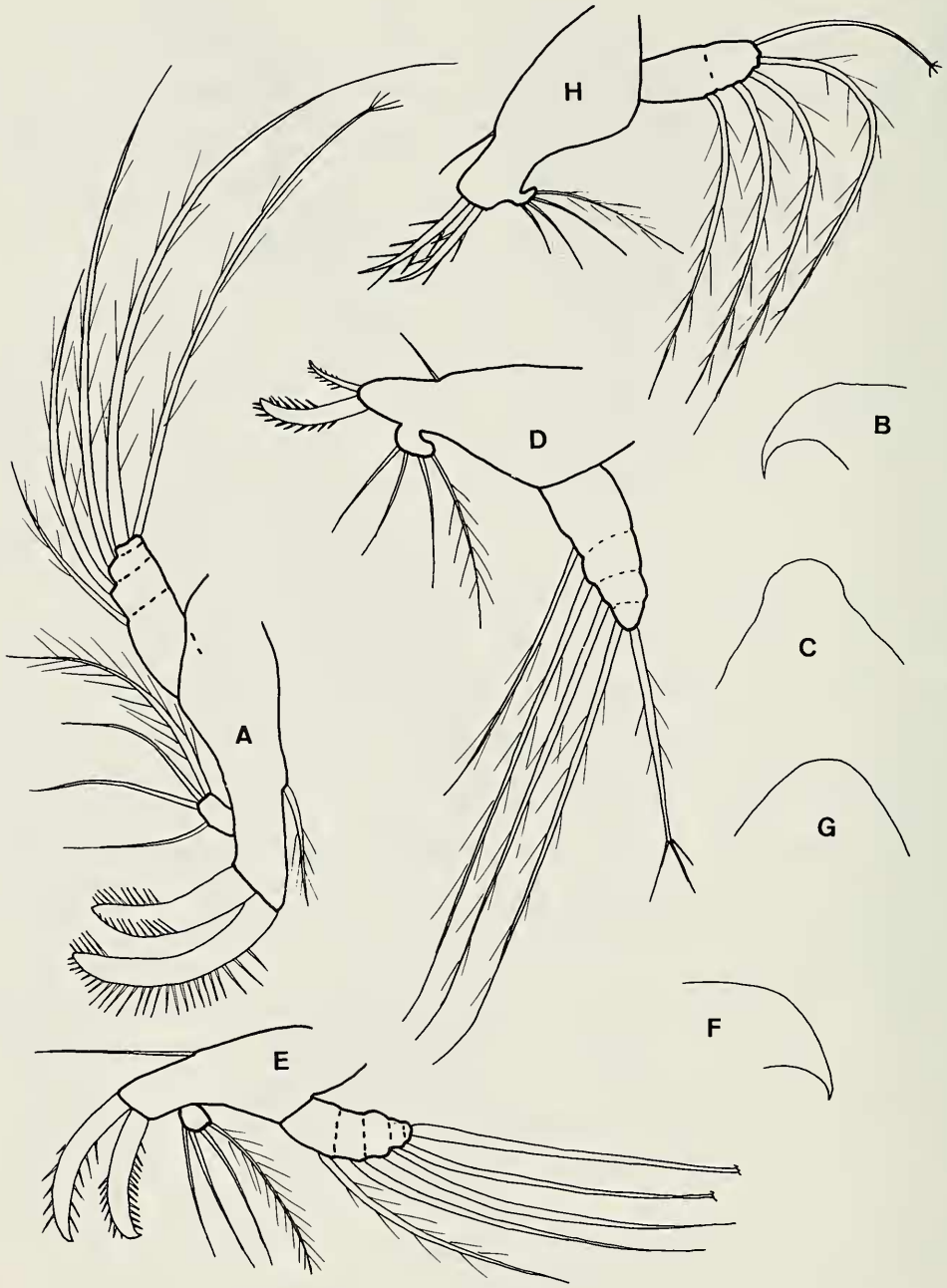

Fig. 3. *Oithona spinulosa*. Female: A, Mn; B, Forehead lateral; C, Forehead dorsal; Male: D, Mn. *Oithona wellershausi*. Female: E, Mn; F, Forehead lateral; G, Forehead dorsal; Male: H, Mn.

centages of Ur segments and CR—13:29:15:14:13:16. Genital segment (Fig. 1B) with a distinct patch of long hairs, midlaterally, both sides; beyond these, 2 rows of small hairs dorsolaterally, terminating ventrolaterally. Ur3 3 or 4 similar rows of small hairs, first row obscured if Ur3 is drawn into genital segment; 4th row present in 9 of 30 specimens. CR (length/

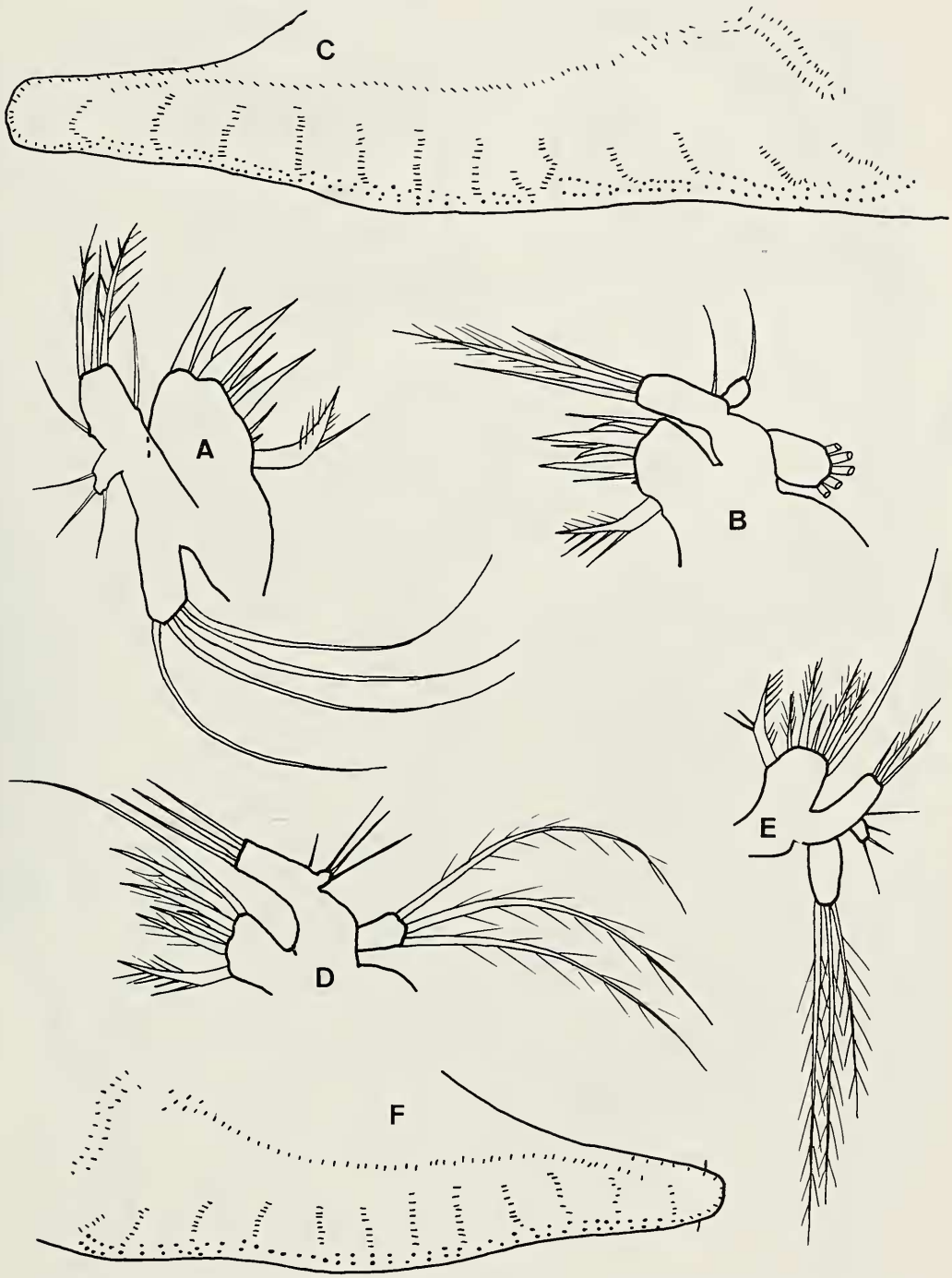

Fig. 4. *Oithona spinulosa*. Female: A, Mx1; Male: B, Mx1; C, Pore signature (right). *Oithona wellershausi*. Female: D, Mx1; Male: E, Mx1; F, Pore signature (left).

width) – 3.0/1. Bsp2Mn (Fig. 3A) 2 thick, curved spines, with spinules; Re 4 poorly articulated segments, 5 setae, apical brush-like; Ri 4 setae, proximal with setules. Bsp2Mx1 (Fig. 4A) 3 distal spines, 2 with spinules; Re 1 segment, 4 naked setae; Ri 3 setae. RePl–4 (Figs. 6A, B, 7A, B) with 1-1-3,

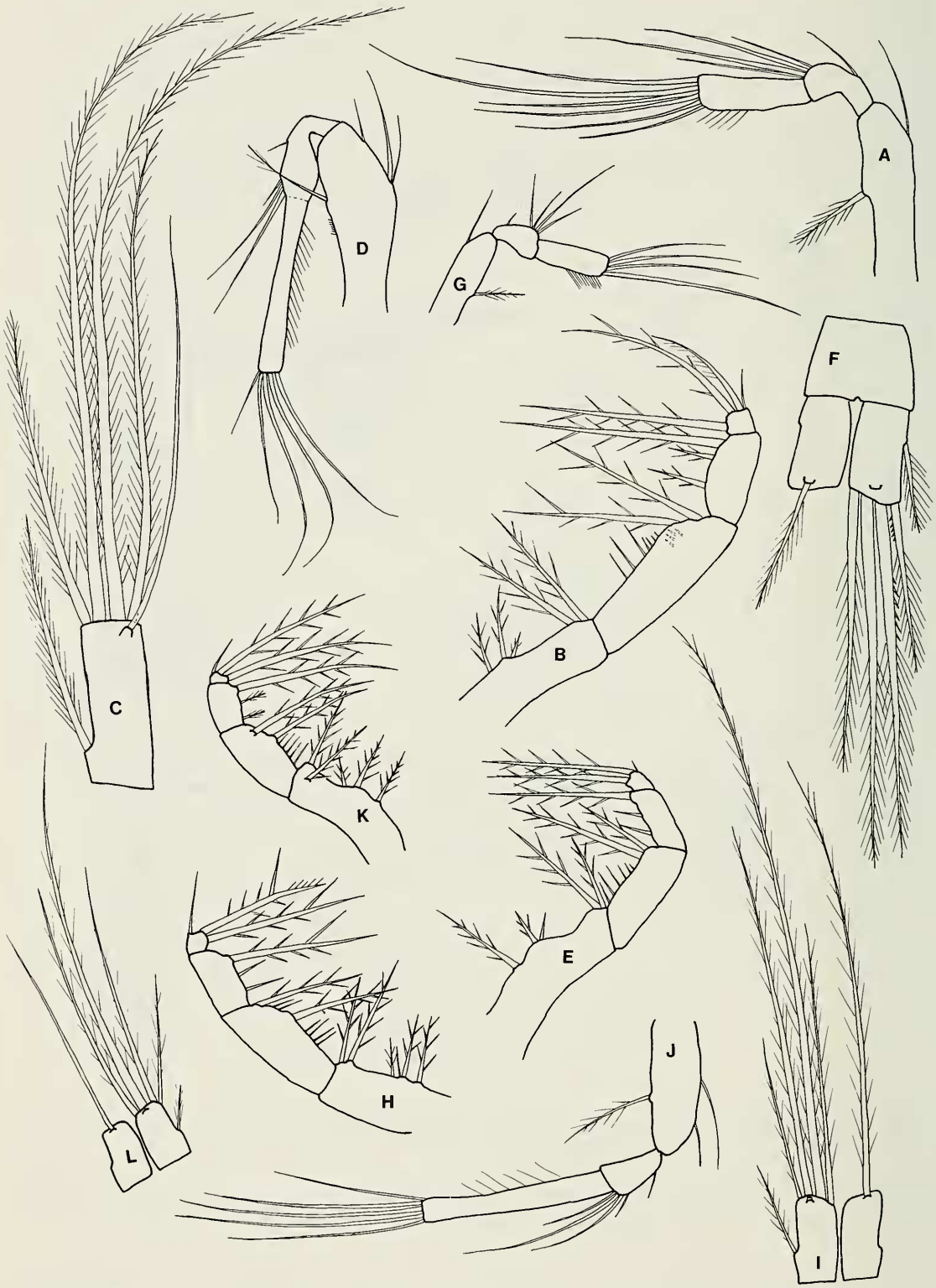

Fig. 5. *Oithona spinulosa*. Female: A, A2; B, Mxp; C, CR dorsal; Male: D, A2; E, Mxp; F, CR dorsal. *Oithona wellershausi*. Female: G, A2; H, Mxp; I, CR dorsal; Male: J, A2; K, Mxp; L, CR dorsal.

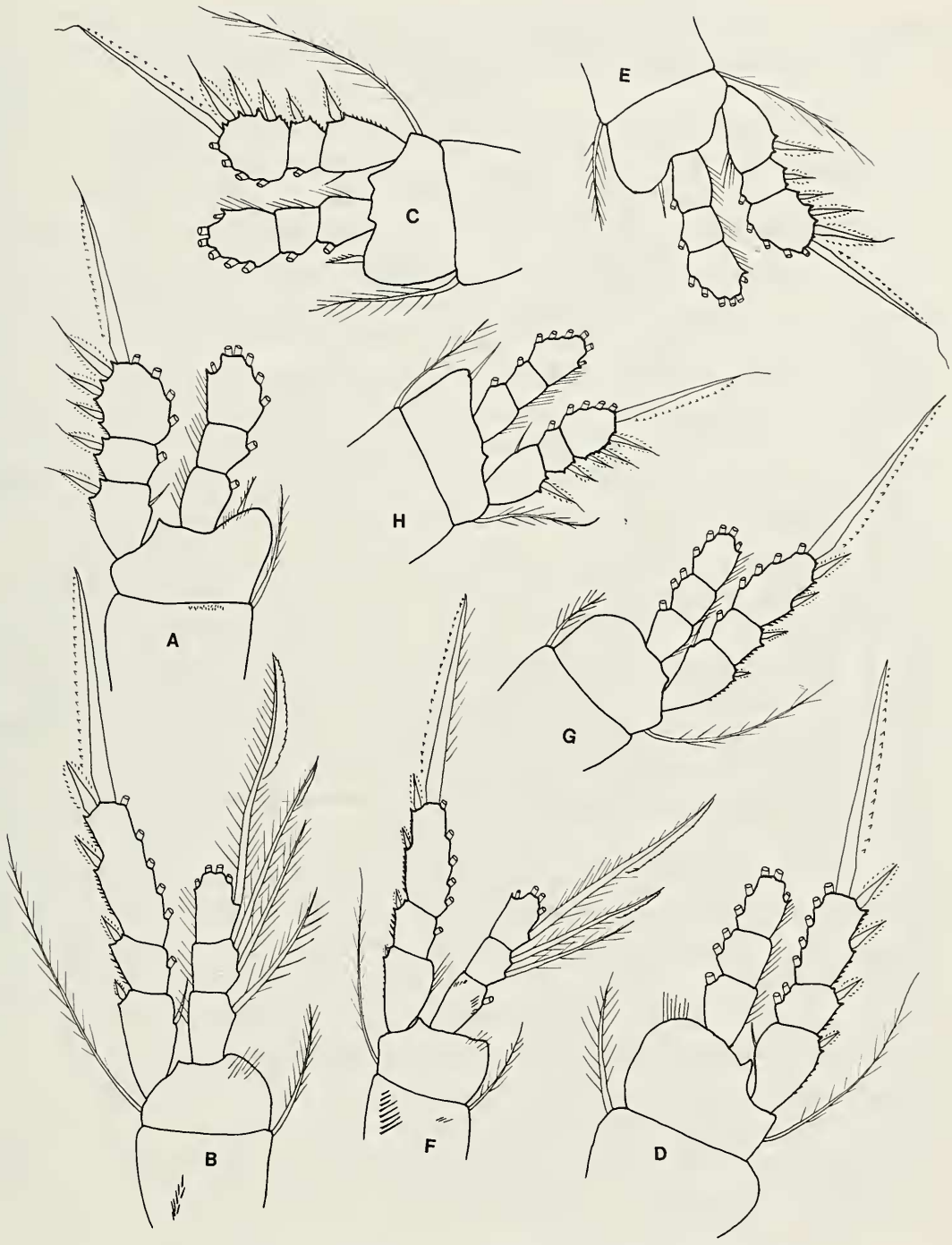

Fig. 6. *Oithona spinulosa*. Female: A, P1; B, P4; Male: C, P1; D, P4. *Oithona wellershausi*. Female: E, P1; F, P4; Male: G, P1; H, P4.

1-1-3, 1-1-3, 1-1-2 Se. Bsp1P4 with row of spinules; Bsp2 few hairs; Re1 Se smallest, remaining Se increasing in length distally; Si1Ri2 unmodified; Si2 straight, small flange on distal $^1/_5$; Si1Ri3 thicker, curved, with well-developed flange on distal ½. P5 (Fig. 1B) ventral seta thick, extending beyond pos-

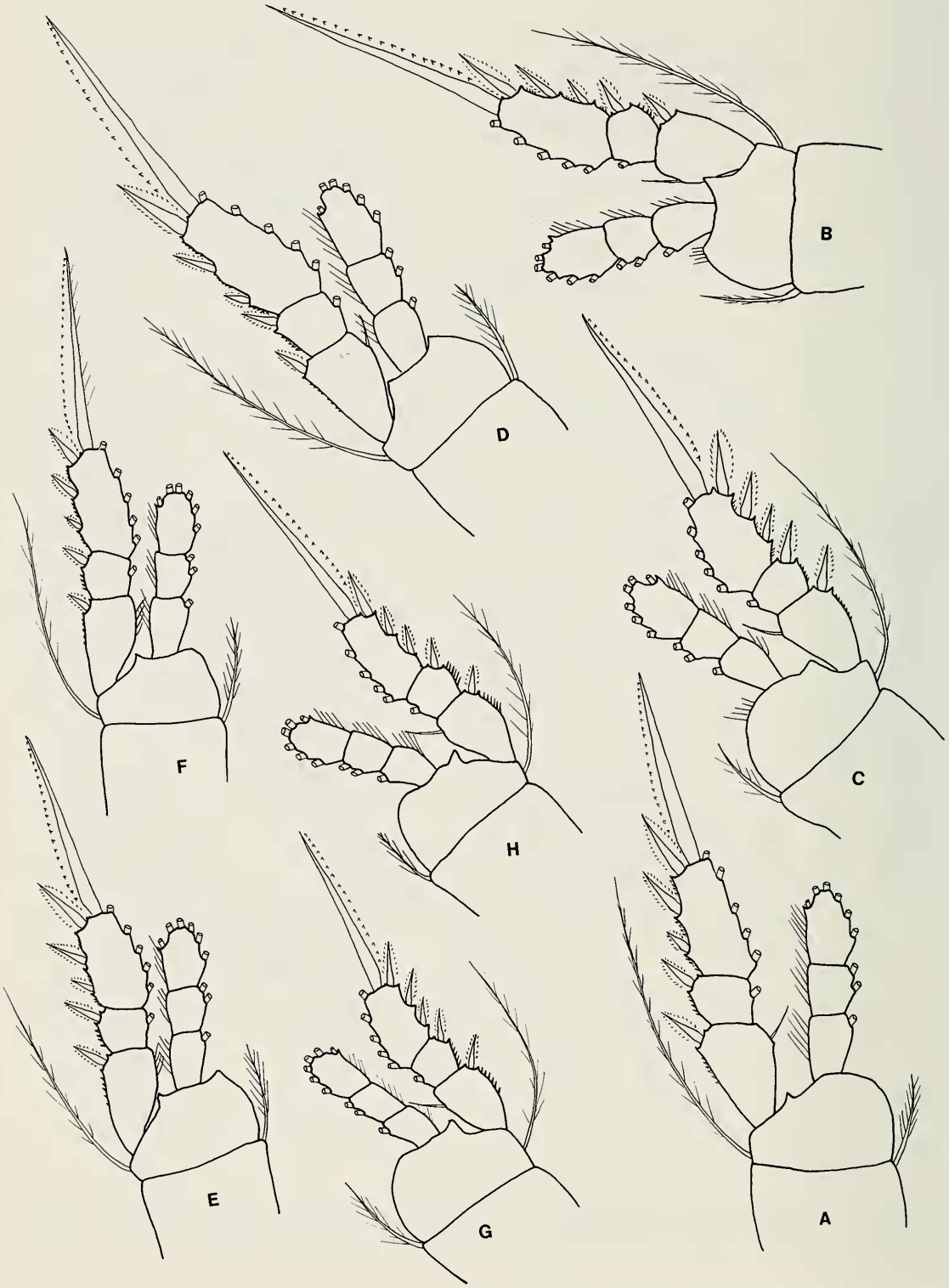

Fig. 7. *Oithona spinulosa*. Female: A, P2; B, P3; Male: C, P2; D, P3. *Oithona wellershausi*. Female: E, P2; F, P3; Male: G, P2; H, P3.

terior margin of Ur3, with thick hairs on distal ⅔. SeCR (Fig. 5C) inserted $^1/_5$ distance from anterior margin of CR; Se 1.5× length of CR; dorsal seta naked.

Male.—Length range 0.53–0.57 mm (30 specimens); Pr/Ur ~ 1.6. Anterior Pr rounded dorsally, rostrum absent. Cph flap (Fig. 1C) extending beyond posterior margin of Pg1. Pore signature (Fig. 4C) of 'hebes' type; anterodorsal cluster 2 lines of organs placed dorsolaterally, anterior line 16–17 organs, posterior 15–16; horizontal row anteriorly as double line of 8–9 organs and single line thereafter, terminating near dorsal end of 12th column; 12 columns, 1st ventral to anterodorsal cluster, 5th J-shaped; horizontal series a double row of organs along ventral edge of Cph and flap. A2 (Fig. 5D) indistinct articulation between segments 2–3; segment 3 elongate. Bsp2Mn (Fig. 3D) 2 dissimilar spines; ventral thick, slightly curved, with spinules, like those of female; dorsal smaller, thinner, slightly curved; Re 4 indistinctly articulated segments, with 5 setae, apical brush-like; Ri 4 setae, proximal with setules. Bsp2Mx1 (Fig. 4B) 3 long thin spines, middle armed; Re 1 segment, 5 setae; Ri with 1 seta. ReP1–4 (Figs. 6C, D, 7C, D) with 1-1-3, 1-1-3, 1-1-3, 1-1-2 Se. P4 lacks modified setae. P5 (Fig. 1C) ventral seta thick but broken on all specimens. Genital flap with 1 thick seta, broken on all specimens. CR (length/width) 2.0/1 (Fig. 5F); all setae reduced compared to female; Se inserted ⅓ distance from anterior border of CR, equal to length of CR; St4 (lateral-most) with spinules on proximal medial margin; St3 spinules on lateral margin; dorsal seta with setules.

Remarks.—(also see Discussion section) 8 females were found with 2 spermatophores (1 on each side) attached to an irregular plate at the ventral edge of each genital groove below the genital armature. An additional female had 3 spermatophores on the left side and 2 on the right. No fertilization tubules were apparent but all structures were in poor condition. Ushima (1979) noted sexual dimorphism in copepodid V of his *O. brevicornis* forma *minor*. A pair of setae are found on the first abdominal segment (Ur2 of that stage) in the males; these setae are absent on the females. I found several copepodid V's of *O. spinulosa*. Those that possessed extra setae on Ur2 also had a tiny cephalosome flap extending just beyond the articulation of the cephalosome and pediger 1. No integumental organs were present on the cephalosome or flap.

Discussion

Difficulties with small, inshore, rostrate, Indo-Pacific species of *Oithona* date from Giesbrecht's (1892) incomplete description of a new female from Hong Kong harbor, *O. brevicornis*. Giesbrecht found no males. His description notes a rostrum similar but not identical to *O. plumifera* and *O. similis*, relative proportions of various prosome and urosome segments, cau-

dal rami considerably longer than the anal segment and 3 times as long as wide. Outer spines of the swimming leg exopods are identical to *O. nana,* 1-1-3, 1-1-3, 1-1-3, 1-1-2. Giesbrecht's illustrations (Table 34, figs. 6, 7) of a dorsal view of the whole animal and lateral view of the forehead, are generally uninstructive other than to confirm various body proportions. The setae of leg 5 and caudal ramus are not shown.

Rosendorn (1917) ascribes specimens of rostrate females with males from the mouth of the Congo River to *O. brevicornis*. Ferrari and Bowman (1980) note unique oithonids apparently found only in a large, western, tropical Atlantic river, the Amazon. Based on present distributional knowledge of estuarine and coastal copepods, it seems unlikely, as both Früchtl (1924) and Herbst (1964) suggest, that Rosendorn's specimens are identical to those Giesbrecht studied.

Früchtl (1924) attributes small (0.41–0.43 mm), inshore, rostrate females from his Sample 1, east exit of Sangi Manumbai, a marine channel between Wokam and Kobroör Islands of Kepulauan Aru, Indonesia, to a local race of *Oithona brevicornis,* which he named *O. brevicornis* forma *aruensis*. In his Table VII (p. 90) he compares these specimens to his designation of the typical form of *O. brevicornis,* Rosendorn's specimens. From that table, the basipod spines on the mandible are described as sharply tapered with strong spinules, not thick and blunt toward the ends. In the text Früchtl does not mention these spines in his discussion of the females but notes them with the males. Früchtl does mention that his specimens differ from Giesbrecht's in their remarkably small size, caudal ramus twice as long as wide, the external seta not twice the length of the caudal ramus, and differences in abdominal length ratios. These females seem similar to the new species, *O. wellershausi*. Früchtl's males of this form are larger (0.58 mm) than his females. Ferrari and Bowman (1980) note that sexual dimorphism in size for small species of *Oithona* is not pronounced. All males I have examined, which can be attributed to females by isolated co-occurrences in samples, are equal to or more often smaller than their conspecific females. Only 1 of Früchtl's 26 males occurred with his *O. brevicornis* forma *aruensis* in Sample 1. The remainder were found with 25 females of his second local race, *O. brevicornis,* forma *arostrata* (0.62 mm) in Sample 2 from the west exit of Sangi Barkai (now Sangi Workai), a marine channel between Kobroör and Maikoor Islands, Kepulauan Aru. The males are probably conspecifics of the latter form. Concerning the identity of this form, well-documented instances of arostrate populations of rostrate, free-swimming copepods are not numerous. A well-known case is the arostrate population of the calanoid *Acartia lilljeborgii* from Saint Lucia, West Indies (Bowman 1965). No arostrate population of a rostrate oithonid has been reported since Früchtl's. It seems more likely that Früchtl's arostrate form (including most males assigned to *O. brevicornis* forma *aruensis*) is identical or closely

related to *O. dissimilis* Lindberg, 1940, an arostrate inshore species (see Ferrari 1977).

Herbst (1964) first introduces Lindberg's (1950) *O. spinulosa* to his discussion of the *O. brevicornis* problem. He compares descriptions of *O. spinulosa* with *O. brevicornis* by Giesbrecht, Rosendorn, and Früchtl to his specimens from Al Ghardaga on the Red Sea. Herbst agrees with Früchtl that Rosendorn's Congo River specimens may not be identical to Giesbrecht's. He also notes that Früchtl's small *O. brevicornis* forma *aruensis* possesses a relatively long genital segment, short caudal ramus, and differences in basipodal spines of the mandible. He mentions that the relative length of the prosome distinguishes *O. spinulosa* but dismisses the hairs on the genital and following segments as easily overlooked or considered insignificant by earlier authors. He does not discuss the long, thick, densely plumed seta of leg 5. Herbst's female specimens from the Red Sea (0.53–0.57 mm) have caudal rami about 3 times as long as wide, with their outer edge seta, inserted near the anterior end of the ramus, only as long as the ramus. Two thick, blunt spines with strong spinules adorn the basipod of a mandible whose endopod has 4 weak setae. Herbst places his specimens in *O. brevicornis* s.l. because the armature of maxilla 1 and absence of hairs on the genital segment of his specimens separate them from *O. spinulosa*. His specimens seem very similar to those originally described by Giesbrecht.

Wellershaus (1969) describes and illustrates two forms of *O. brevicornis* from the Cochin Backwaters, India, and further describes specimens from Hong Kong harbor. Females of the typical form from Cochin seem to me identical to *O. spinulosa,* a fact Wellershaus admits. But he maintains that Lindberg's species is similar to Giesbrecht's. He suggests that "main characters" used by Lindberg to differentiate *O. spinulosa* are not reported by Giesbrecht. Aside from the fact that Wellershaus has been very conservative in recognizing Lindberg's species (see Ferrari 1977, for a redescription of *O. dissimilis*), it is difficult to believe that Giesbrecht would have overlooked an unusually armed, long, thick seta on leg 5 or hairs on the genital segment of his Hong Kong specimens. Wellershaus' specimens also agree closely with those of *O. spinulosa* from the Pearl River area with respect to most details, especially the armature and degree of sexual dimorphism of the mandible. My specimens are slightly smaller (0.57–0.64 mm) and have a small flange on the distal tip of 2 endopodal setae on leg 4.

Wellershaus' smaller form of *O. brevicornis* from Cochin agrees with the new species in such details as he mentions: relative proportions of the anal segment and caudal ramus; ornamentation of the setae of leg 5 and caudal ramus; position of external seta on caudal ramus; absence of hairs on genital and following segments; armature of mandible.

Wellershaus' specimens of *O. brevicornis* from Hong Kong are notewor-

thy in several respects. They are collected from the harbor; it is not unreasonable to assume that this was the source of Giesbrecht's specimens. They are similar to Giesbrecht's in those characters available for comparison: size; ratios of prosome to urosome, length to width of anal segment and caudal ramus; absence of hairs on genital and following segments; undistinguished seta on leg 5. Wellershaus notes that the mandible of these males is similar to the Cochin large form. Thus males of *O. brevicornis,* like *O. spinulosa,* have on the large basipod one spine like the female and a second, reduced in size, with longer spinules. Specimens of *O. brevicornis* from the Yellow and East China Seas reported by Chen *et al.* (1974) cannot be distinguished from *O. spinulosa* based on descriptions and illustrations given.

In 1975 Bowman correctly separated the temperate, rostrate, inshore species, *Oithona colcarva,* of the east and gulf coasts of the United States from the tropical, Indo-Pacific, rostrate *O. brevicornis*. Specimens of *O. brevicornis* forma *major,* reported by Nishida *et al.* (1977) from Suruga and Tokyo Bays, are similar to *O. spinulosa* in position of external seta of the caudal ramus. The authors consider these animals identical to Wellershaus' typical form. The seta of leg 5 is described "with abundant hair" but not unusually thick; hairs are not reported on any urosome segment. Nisheda *et al.* note that their *O. brevicornis* forma *minor* is similar to the small form of Wellershaus and *O. brevicornis* forma *aruensis* of Früchtl. The male mandible is similar to *O. wellershausi* with its identical but sexually dimorphic basipod spines. However, their female (Fig. 4a, p. 54) has a caudal ramus whose length appears greater than twice its width. Ushima (1979) reports on the ontogenetic development of *O. brevicornis* from a brackish water harbor in Tokyo Bay. Ushima identifies his specimens as *O. brevicornis* forma *minor* of Nishida *et al.* and again the caudal ramus length appears more than twice its width (Fig. 3k). One interesting feature of Ushima's study is the position and armature of the nauplius mandible (Fig. 1a). It appears that the basipod spines, which exhibit so much diversity in adult animals, may act as the primary food-grinding structures of the nauplius.

Despite the apparent orderliness of the above account much remains to be done with tropical, inshore, Indo-Pacific species of *Oithona*. A complete description of male specimens of *O. brevicornis* from its probable type-locality, Hong Kong harbor, is of primary concern. Future investigators should attempt to describe and illustrate accurately such features as: male and female mandible and maxilla 1, noting the degree of sexual dimorphism; female leg 4 with modified setae; leg 5 of male and female; armature of genital openings; male pore signature. The pore signature, already described for 3 Indo-Pacific, inshore species, *Oithona dissimilis* (see Ferrari 1977), *O. wellershausi,* and *O. spinulosa,* has proven useful in separating males of these easily-differentiated species. However, the inshore areas of the Indo-Pacific are represented by a diverse number of environments, presenting these tiny cyclopoids singular opportunities for speciation. There is no rea-

son to believe all species have been encountered. As sampling of coastal environments increases, the picture of *Oithona* diversity will only become more complex but with careful descriptive work, it is hoped, not more confusing.

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